	NUMBER OF INTERSECTIONS	PERCENTAGE
Major intersections with signalized traffic	289	100%
Pedestrian Signals	81	28%
No pedestrian signals	208	72%

TABLE 3.3
Major intersections with Pedestrian Signals

RECOMMENDATIONS

The recommendations in this section focus primarily on future sidewalk improvements as part of the City of Greensboro sidewalk construction program and on intersection improvements for pedestrian signals and curb ramps. Other improvements identified in the **Pedestrian "Toolbox"** are recommended on a case-by-case basis and have not received a formal prioritization process. In addition, although Guilford County and the incorporated towns within the MPO were not analyzed as part of this process, the Town of Oak Ridge has developed a **Pedestrian Plan** and prioritized pedestrian improvements with the assistance of the NCDOT Bicycle and Pedestrian Planning Grant Initiative. The Town of Pleasant Garden has completed its **Comprehensive Bicycle and Pedestrian Transportation Plan** with funding from the Planning Grant Initiative, and the Town of Sedalia will complete its own plan in 2015. The **Oak Ridge Comprehensive Pedestrian Plan** and the recommendations from the **Town of Pleasant Garden Comprehensive Bicycle and Pedestrian Transportation Plan** are included in the **BiPed Plan Update** in recognition of the local priorities of the towns and their pedestrian planning. The plan that is developed for the Town of Sedalia will be incorporated into the BiPed Plan when it is completed in 2015. Priorities from other towns and Guilford County, if known, are also included.

The City of Greensboro developed recommendations for prioritizing sidewalk needs and improving intersections using GIS modeling and a performance based process. This was done in part

to rise to the challenge of the performance measurement element in the federal transportation authorization bill Moving Ahead for Progress in the Twenty-First Century (known as MAP-21) and its implementing regulations. However, this approach of utilizing advanced GIS technology also offers many other advantages, including:

1. data are evaluated systematically and automatically to address high need locations;

2. data are analyzed comprehensively in terms of space which is not feasible through a manual evaluation; and

3. conflict and ambiguous decisions are avoided.

This approach will be summarized in more detail in the following sections

Sidewalks

The City of Greensboro has had an aggressive independent sidewalk project construction program since 2003. From the start, the process has been guided by a needs based prioritization effort. GDOT has employed strong conceptual and analytical underpinnings in its analysis of sidewalk needs throughout the City and in its methods for achieving equity in sidewalk investment across City Council districts. For years this was conducted via exhaustive manual evaluations. Although the manual process has proven effective, it is time consuming to apply. GDOT has now developed a GIS model to implement and refine this process through the use of systematic GIS tools. The goal was to streamline the process and to gain efficiencies from systematic automated evaluation.

In order to ensure the GIS model produces results consistent with the manual method, the conceptual model and the GIS implementation were reviewed and the results of this new approach were compared with the locations of 41 sidewalk projects planned for implementation in the short term between 2014 and 2017. These projects were selected manually by professional transportation planners, engineers, and managers using needs-

based criteria and in consideration of geographic equity between City Council districts. A review of the results demonstrated that over 85% of sidewalk projects manually planned by planning experts and managers in the City of Greensboro matched with those prioritized into the short term tier using the proposed methodology. This impressive accuracy on the first tier of the planned sidewalk projects implies the reliability of this prioritization method in providing recommendations for sidewalk implementation planning.

In determining where sidewalks should be prioritized in the sidewalk construction program, a basic consideration is that sidewalks should be placed where pedestrian traffic is expected and or/encouraged. Mixed-use development and diversity of land uses promote more walking trips. Common pedestrian attractors include schools, grocery stores, employment centers, parks, recreation centers, trails and greenways, and transit stops. Bus stops activate pedestrian travel since people are pedestrians on their way to the bus and after they dismount from the bus. Other clear indications of needed sidewalk show up as worn paths along roadways.

Based on the trip attractors listed above, a literature review, survey results from the BiPed Update Advisory Committee meeting held in the Greensboro Urban Area Metropolitan Planning Organization in February 2014, and a public survey for the BiPed Plan Update in the Greensboro MPO area available from May to August 2014, nine criteria were selected for scoring and prioritizing sidewalks. These criteria are:

1. Land use connection
2. Land use diversity
3. Proximity to transit stops and number of transit users
4. Proximity to greenways and trails
5. Sidewalk gaps
6. Road classification

7. Number of households under the poverty level
8. Number of workers commuting to work with no vehicle
9. Pedestrian crashes

Each criterion is briefly described below. As part of the analysis, any street segments that did not have sidewalks on either side were used to calculate each criterion above, and were then assigned a total score.

1. **Land use connection** The land use connection criterion was used to determine whether a road segment led to key pedestrian trip generators and attractors as indicated by the following land use types: employment/shopping centers, schools, parks and open spaces, high density or multi residential areas. The more of those land use types found within a quarter mile of a segment, the higher score the segment had for this criterion.

2. **Land use diversity** The land use diversity criterion was included in this analysis in recognition that more diverse areas reflect greater demand for sidewalks, and because there is a positive correlation between mixed land use and walkability.[15,16] Mixed land use also has a significant influence on the trip length and the modal share of non-motorized and transit modes.[17] In this plan, we used the Simpson Index[18] to calculate land use diversity based on the input land use shapefile for a 50-feet grid covering the entire city of Greensboro. The equation for the Simpson Index is:

$$D = 1 - \sum p_i^2 = 1 - \frac{\sum_{i=1}^{n} n_i^2}{N^2}$$

Where D is the diversity index (0 = no diversity; 1 = diversity), N the total area or cells of all land use categories, and n_i the total area or cells of a particular land use i[th]. In other words, the equation calculates the degree of variation in the land use pattern. Areas with a higher score reflect a more varied land use pattern. **Map 3-4** displays the land use diversity index of the Greensboro MPO.

[15]Hall, K.S. and E. McAuley, *Individual, social environmental and physical environmental barriers to achieving 10,000 steps per day among older women*. Health education research, 2010. 25(3): p. 478-488
[16]NBrown, B.B., et al., *Mixed land use and walkability: Variations in land use measures and relationships with BMI, overweight, and obesity*. Health & place, 2009. 15(4): p. 1130-1141
[17]Bordoloi, R., et al., *Quantification of Land Use diversity in the context of mixed land use*. Procedia-Social and Behavioral Sciences, 2013. 104: p. 563-572.
[18]Simpson, E.H., *Measurement of diversity*. Nature, 1949.

2015
BIPED PLAN
UPDATE

Map 3-4

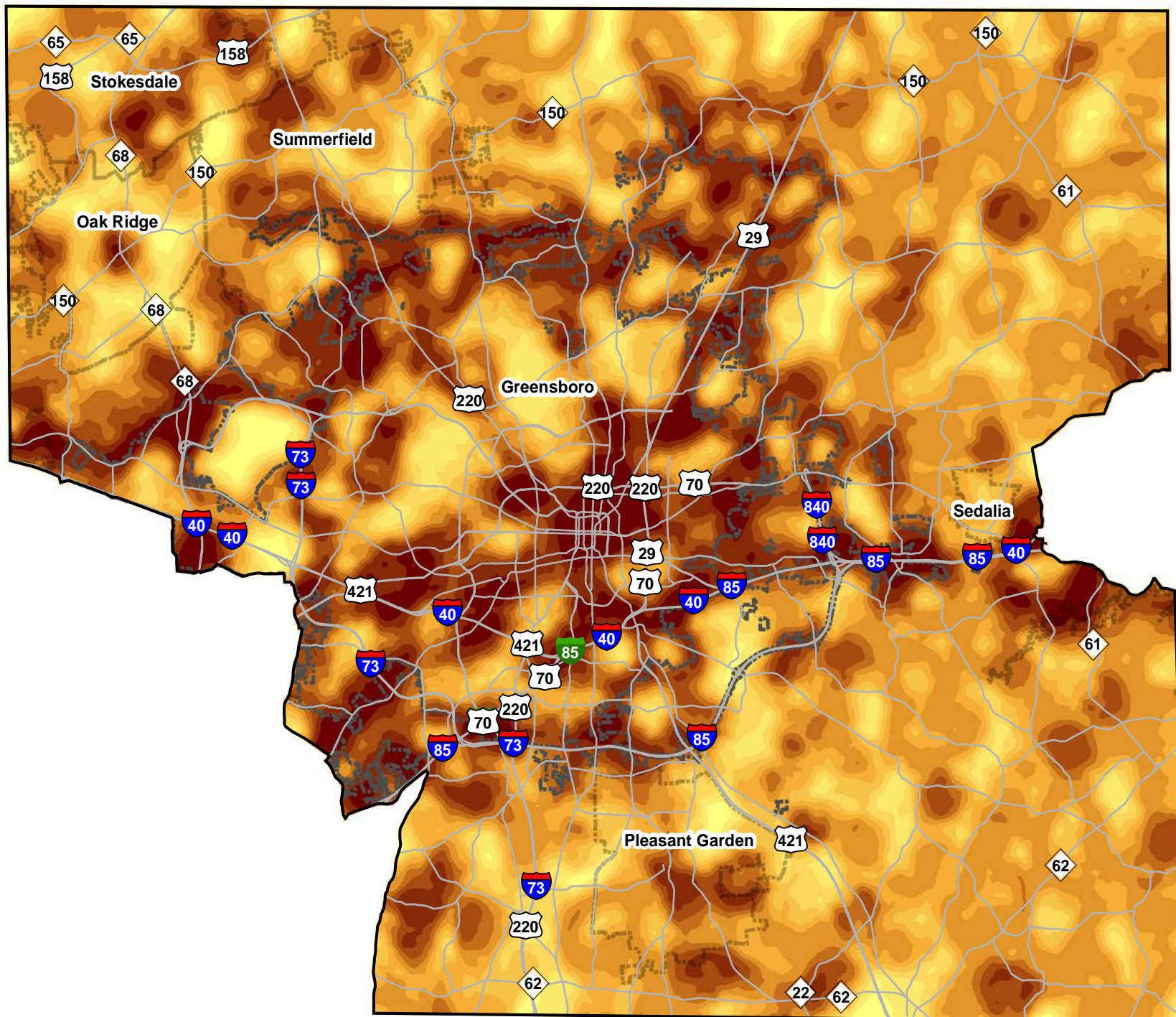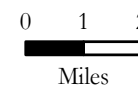**LAND USE DIVERSITY INDEX**

Legend

Land Use Diversity Index
- 0 - 0.07 (Low)
- 0.08 - 0.19
- 0.2 - 0.29
- 0.3 - 0.38
- 0.39 - 0.45
- 0.46 - 0.52
- 0.53 - 0.58
- 0.59 - 0.65
- 0.66 - 0.72
- 0.73 - 0.86 (High)

Major Street

Town Limits

City of Greensboro

Greensboro MPO

N
W E
S

0   1   2
Miles

greensboro urban area
MPO
metropolitan planning organization

3. **Proximity to transit stops and number of transit users** Bus riders need sidewalks to access bus stops safely and conveniently, especially if they have mobility impairments. Therefore, the proximity of road segments to transit stops was accounted for in this method to ensure that road segments leading to bus stops had higher priority for sidewalk implementation than the others. The number of transit users was accounted for by identifying whether there were any road segments whose quarter-mile buffer contained at least one bus stop in the list of top 50 bus stops having the highest number of transit users according to the Greensboro Transit Authority.

4. **Proximity to greenways and trails** Greenways and trails are considered as a means to promote walking. However, studies have shown that inaccessibility to trails may have a negative effect on the decision to walk[19]. Proximity to greenways and trails was an important concern of the public in developing new sidewalk, based on the 2014 public survey.

5. **Sidewalk gaps** Studies have shown that sidewalk gaps are walking barriers.[20] In fact, sidewalk gaps create difficulties for pedestrians, especially people with mobility limitations such as wheelchair users or those walking babies in strollers. Filling sidewalk gaps was an important concern reflected in the 2014 public survey.

6. **Road classification** Roads in the city of Greensboro are grouped into four classes: major thoroughfares, minor thoroughfares, collector streets, and local roads. Major thoroughfares have the highest vehicle and pedestrian density because they provide crucial linkages between important destinations such as shopping centers, employment centers, schools, and bus stops. Major thoroughfares also provide some of the most direct pedestrian routes in many areas. Due to their high pedestrian demand, more pedestrian crashes are expected along these major roads compared to other classes of roads due to the high density of destinations along them.[21,22,23] In other words, the reason for these crashes has been found to be related to the increase in the number of vehicles and/or pedestrians around the destinations.[24] Implementing new sidewalks along major roadways is an important approach to reducing and preventing pedestrian crashes on these roadways. In this analysis, major roadways receive greater weight in the prioritization then non-major roadways.

7. **Number of households under the poverty level and number of workers commuting to work with no vehicle** Households under the poverty level and workers commuting with no vehicle tend to make more walking trips than other households by necessity.[25,26] Therefore areas with higher than average numbers of households in poverty and workers commuting without a motor vehicle gain additional weight in the prioritization process since they are associated with increased amounts of walking.

8. **Pedestrian crashes** Pedestrian crashes have been found to be associated with the absence of sidewalks and buffers against traffic.[27] It was the most important criteria in prioritizing sidewalk indicated on the 2014 public survey, with 53.6% of responders in support of using it. Consequently, an objective of this analysis was to ensure that road segments that have pedestrian crashes within a quarter-mile received greater weight in this analysis then in areas without a crash history. More information about pedestrian crashes is located in the *Safety Section* of this chapter.

[19]Brownson, R.C., et al., *Promoting physical activity in rural communities: walking trail access, use, and effects*. American journal of preventive medicine, 2000. 18(3): p. 235-241.
[20]Lee, C. and A.V. Moudon, *Physical activity and environment research in the health field: implications for urban and transportation planning practice and research*. Journal of planning literature, 2004. 19(2): p. 147-181.
[21]Schuurman, N., et al., *Pedestrian injury and the built environment: an environmental scan of hotspots*. BMC public health, 2009. 9(1): p. 233.
[22]Jiao, J., A.V. Moudon, and Y. Li, *Locations with Frequent Pedestrian-Vehicle Collisions: Their Transportation and Neighborhood Environment Characteristics in Seattle and King County, Washington, in Planning Support Systems for Sustainable Urban Development*. 2013, Springer. p. 281-296.
[23]Newbury, C., et al., *Paediatric pedestrian trauma: the danger after school*. Journal of paediatrics and child health, 2008. 44(9): p. 488-491.
[24]McMahon, P.J., et al., *Analysis of factors contributing to" walking along roadway" crashes*. Transportation Research Record: Journal of the Transportation Research Board, 1999. 1674(1): p. 41-48.
[25]Li, F., et al., *Multilevel modeling of built environment characteristics related to neighbourhood walking activity in older adults*. Journal of Epidemiology and Community Health, 2005. 59(7): p. 558-564.
[26]Turrell, G., et al., *Can the built environment reduce health inequalities? A study of neighbourhood socioeconomic disadvantage and walking for transport*. Health & place, 2013. 19: p. 89-98.
[27]Hanson, C.S., R.B. Noland, and C. Brown, *The severity of pedestrian crashes: An analysis using Google Street View imagery*. Journal of Transport Geography, 2013. 33: p. 42-53.

Introduction

Infrastructure

> Pedestrian
Accommodations
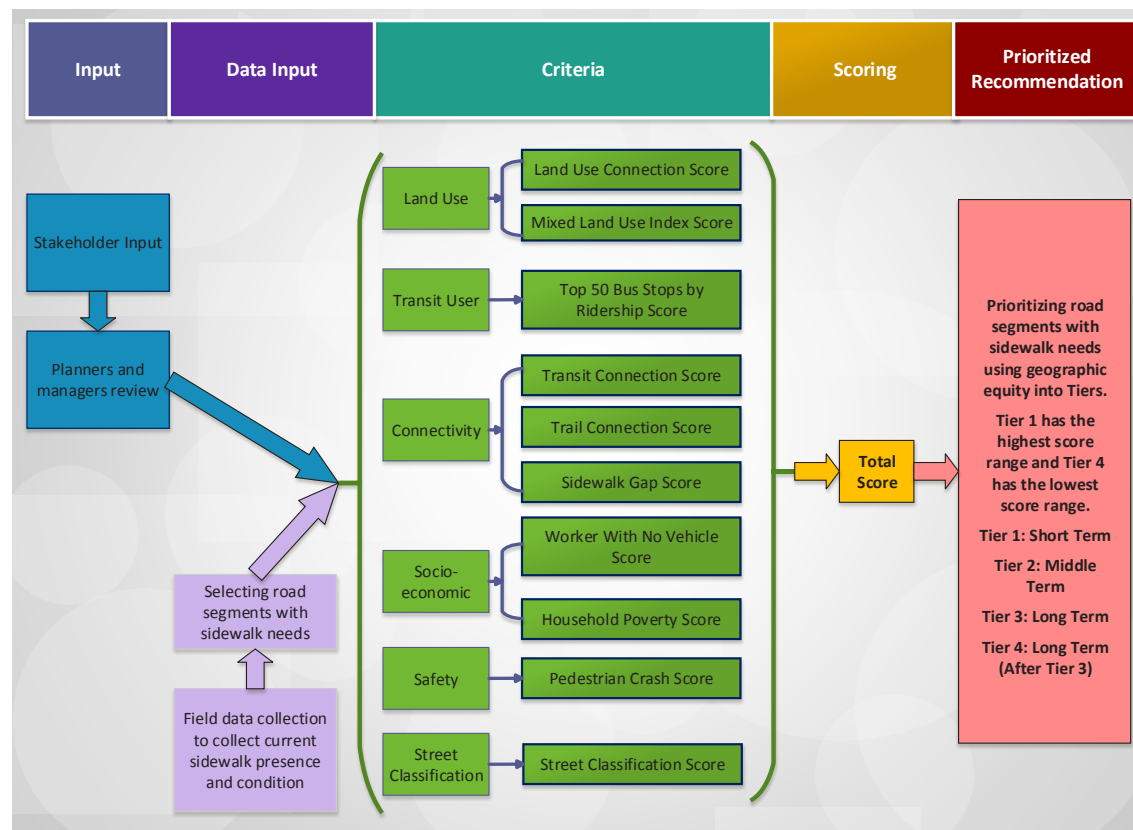
Usage and Volume

Maintenance

Safety

Policies & Programs

Summary

FIGURE 3.2
Sidewalk Prioritization Flow Chart

The overall procedure of the prioritization is summarized in **Figure 3.2**.

The output from the prioritization process is a score that indicates how the level of need for a given roadway segment compares to the level of need on other roadway segments across the whole City. At that point the data was further processed to address geographic equity between City Council districts. Put simply, the geographic equity adjustment sorts projects into priority tiers relative to other needs in that district. This is done in response to policy directives from the City Council to achieve a balanced set of priorities spread across each of the City's five City Council districts.

From this process, sidewalk recommendations are prioritized into four tiers: Tier 1 (top priority/short term), Tier 2 (second priority/ middle term), Tier 3 (third priority/long term), and Tier 4 (long range). Road segments that fell below the minimum threshold for Tier 4 are considered unclassified.

Map 3-5 displays the results of the prioritization process throughout the City of Greensboro. The City and the Greensboro MPO will use this map to review the merits of proposed sidewalk projects and identify areas that may be underserved. Independent priority project selection will tend to follow the priorities established in the tiers, but projects may be selected from any tier, or even from unclassified segments as needed, based on a review of on the ground conditions and/or community priorities.

Map 3-5A

**SIDEWALK
PRIORITIZATION
-
CITY OF
GREENSBORO**

Legend

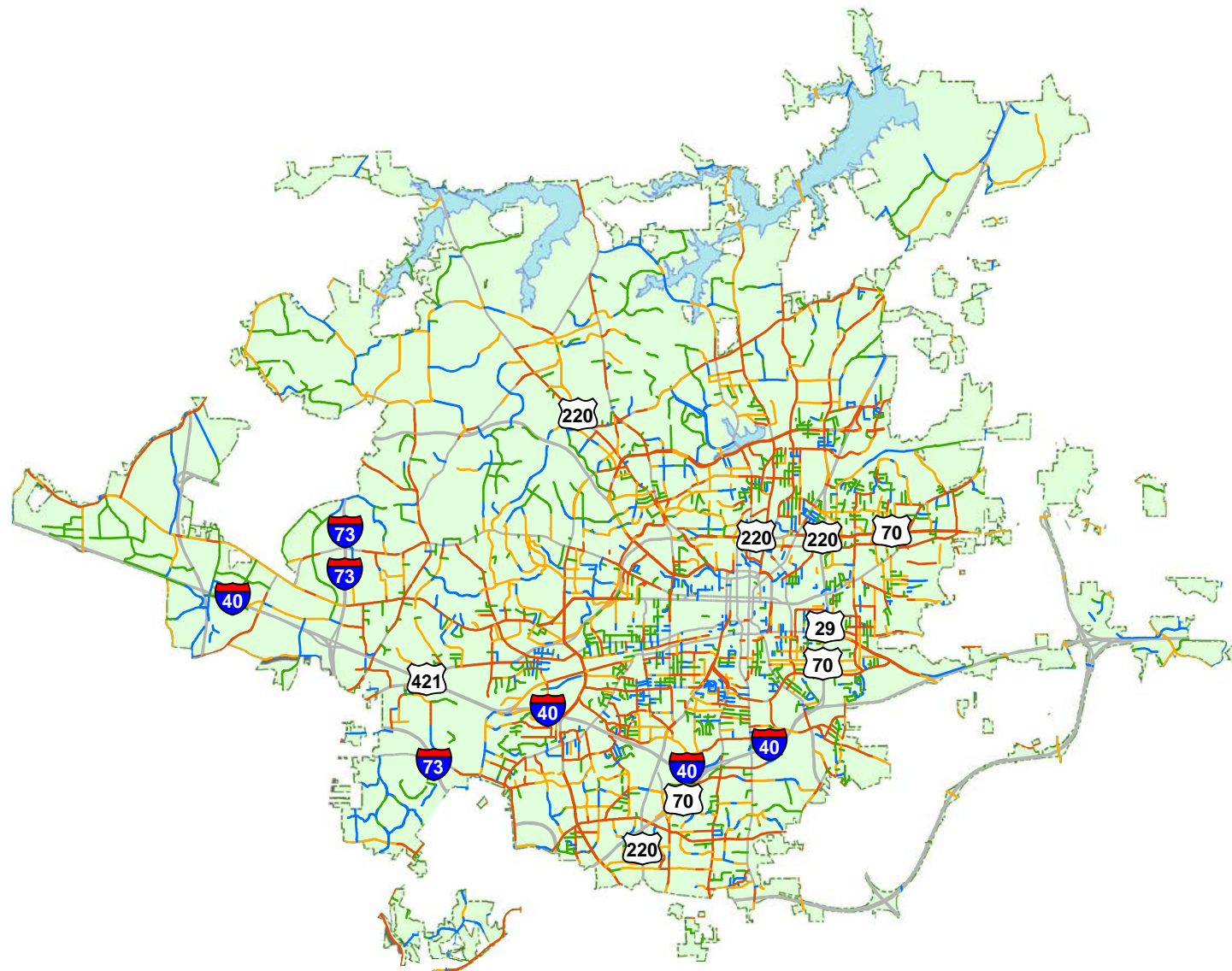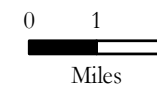**Sidewalk Priority
Tiers**
— 1 (Short Term)
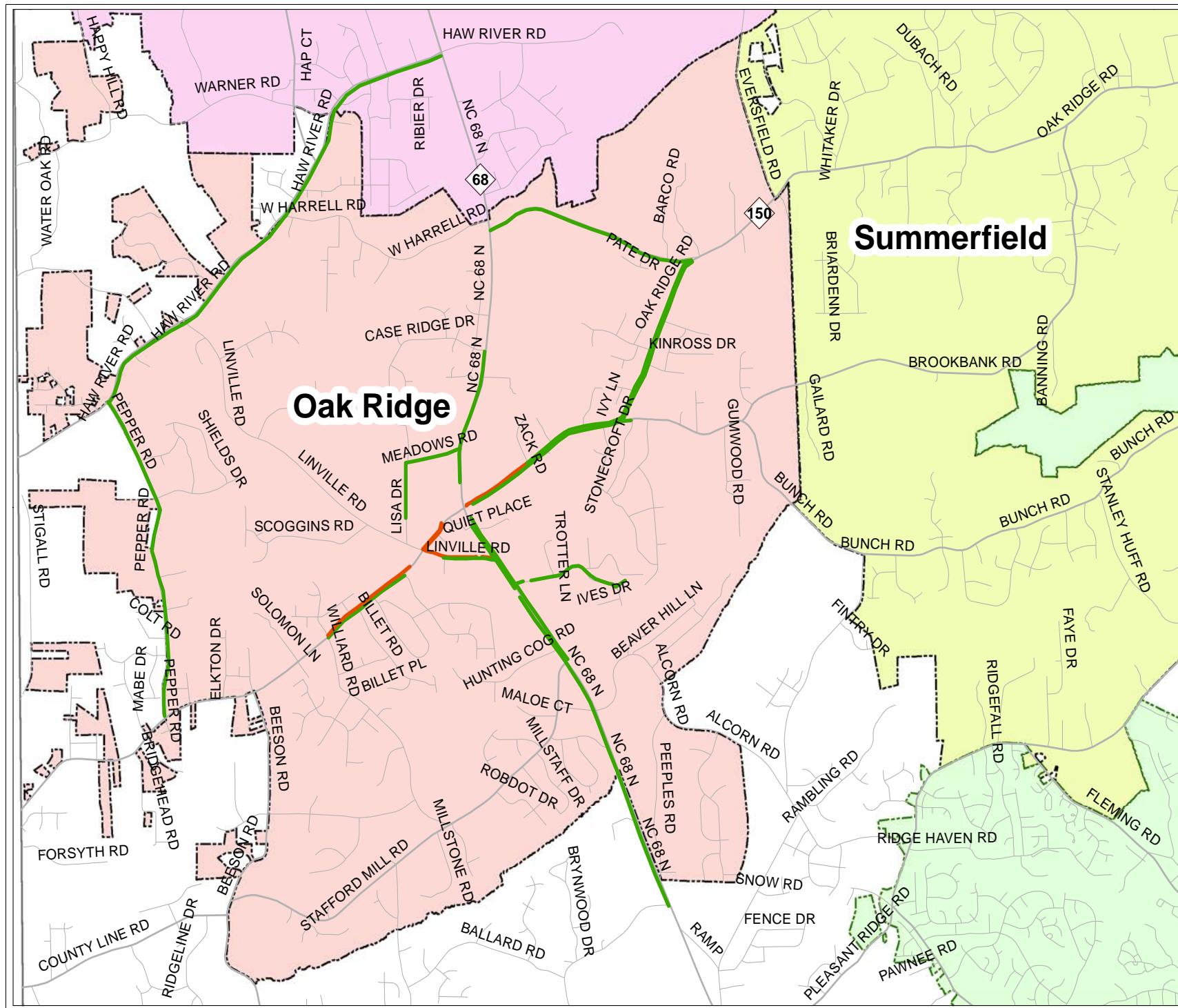— 2
— 3
— 4 (Long Term)
Major Street

Lakes

City of Greensboro

N
W E
S

0   1   2

Miles

greensboro urban area
MPO
metropolitan planning organization

Map 3-5B

PRIORITY
SIDEWALK
IN OAK RIDGE

Summerfield

Oak Ridge

Legend

Sidewalk Priority
— Top Priority
— Low Priority
Major Street

N
W   E
S

0   0.25   0.5
Miles

greensboro urban area
MPO
metropolitan planning organization
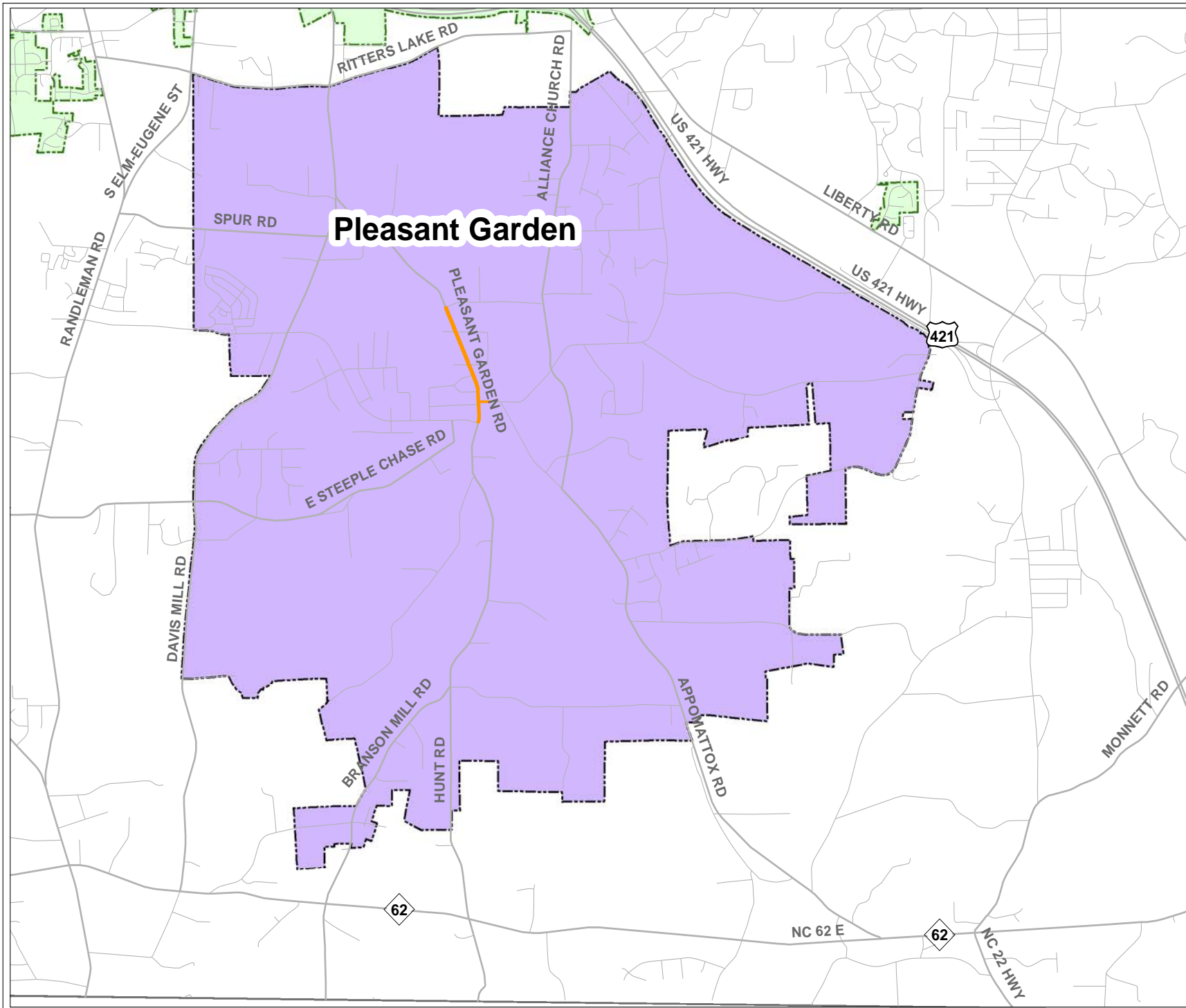
RITTERS LAKE RD

S ELM-EUGENE ST

ALLIANCE CHURCH RD

US 421 HWY

LIBERTY RD

US 421 HWY

Map 3-5C

**SIDEWALK
PROJECT
ALTERNATIVE
RECOMMENDATIONS
IN
PLEASANT
GARDEN**

421

SPUR RD

Pleasant Garden

RANDLEMAN RD

PLEASANT GARDEN RD

E STEEPLE CHASE RD

Legend

Proposed Sidewalk

Street Centerline

Major Street
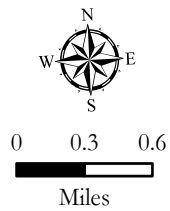
DAVIS MILL RD

BRANSON MILL RD

HUNT RD

APPOMATTOX RD

MONNETT RD

N
W E
S

0   0.3   0.6

Miles

62

62

NC 62 E

62

NC 22 HWY

**greensboro urban area
MPO
metropolitan planning organization**

It should be noted that many of the Tier 1 sidewalk priorities identified on the map already have projects in development or implementation. See the *Implementation* portion of this section to review the current projects of the sidewalk construction program.

Sidewalks in the Guilford County and the Towns have not been prioritized in this Plan, except to the extent those Town sidewalk priorities are known. This is mainly because there is no sidewalk construction program outside the city limits and sidewalks are normally built through private developments, the locations of which cannot be predicted. As noted above, NCDOT can build sidewalks when it is widening or constructing a new roadway, but will charge local governments for a portion of the cost to do so. This plan recommends that NCDOT rescind this policy and instead routinely accommodate pedestrians with sidewalks in urban and urbanizing areas.

In terms of Town priorities for sidewalk, Oak Ridge and Pleasant Garden, which have completed plans to prioritize pedestrian improvements, have also prioritized sidewalks within their boundaries. Oak Ridge currently has funds budgeted to construct sidewalk on the north side of NC 150 between Linville Rd and NC 68. Future top priority sidewalk projects for Oak Ridge will focus on the Town Core, particularly on NC 150 and Linville Rd. Twenty-four individual sidewalk projects have been identified in their *Pedestrian Plan*. The Town hopes to budget for about one sidewalk project per year. **Map 3-5B** shows the top priorities and future proposed sidewalk in Oak Ridge. For more information, please refer to the *Town of Oak Ridge Comprehensive Pedestrian Plan*.

Pleasant Garden prioritized bicycle and pedestrian improvements in their *Town of Pleasant Garden Comprehensive Bicycle & Pedestrian Transportation Plan*. Most of the recommended projects are either paved shoulders or sidepaths, but there are two sidewalk projects recommended in their Plan – both of which are possible alternates to sidepaths. The first is on Pleasant Garden Rd between Ryegate Rd and E Sharaton Park Rd, which has been recommended as either a sidepath on the west side or bike lanes and sidewalks on both sides. The second is a short section of sidewalk along the south side of Neelley Rd between the parking lot for Pleasant Garden Elementary and Pleasant Garden Rd, a distance of about 400 feet. It remains to be seen which alternative the Town of Pleasant Garden will choose, so each of the possible recommendations – sidepaths, sidewalks, bike lanes, and paved shoulders – have been included in the BiPed Plan in the respective modal chapters. The locations of the sidewalk alternatives are displayed on **Map 3-5C**. For more information please review the *Town of Pleasant Garden Comprehensive Bicycle & Pedestrian Transportation Plan*.

Other Sidewalk Prioritization Methods: Greensboro's Sidewalk Petition Program for Neighborhood Streets

Over the course of the sidewalk construction program, the City has generally prioritized major thoroughfares for sidewalk installation as a matter of connectivity, safety, and to support transit ridership. Local streets in existing neighborhoods are generally not selected as priority projects except in cases where there is a significant demonstrated safety, accessibility, and/or land use need. The City's petition program for local streets is used to identify areas where a majority of residents and local property owners favor new sidewalk construction. This process is resident-driven and relies upon the motivation of the petitioner to get support from their neighbors for a potential project. GDOT administers this process and requires that a majority of the residents along the side of the affected street (or both sides of the street for sidewalk on both sides) support the potential project. Successful sidewalk petition projects are put in the queue alongside priority projects for implementation when they are ready (contingent on funding availability). In this way, residents can make sidewalk construction in their neighborhood a City priority.

Criteria for intersection improvements: pedestrian signal and ADA ramp installation

Similar to the sidewalk prioritization model, intersections were analyzed for needed improvements of pedestrian signals and curb ramps within the City of Greensboro. This methodology using GIS modeling was originally developed for the Transportation Alternatives Program (TAP), a competitive federal grant program that funds bicycle and pedestrian improvements within the Greensboro MPO. The Greensboro MPO developed a conceptual model in consideration of needs based criteria including crash histories and trends, land uses, transit access, and other variables. The GIS model was structured to implement the conceptual model and analyzed all signalized intersections in Greensboro for needed pedestrian signal upgrades. The GIS model was also used to identify crash hotspots needing effective, short term countermeasures. The methodology is described in **Table 3.4**. Four criteria used to prioritize pedestrian signals and ADA curb ramps include land use connectivity, transportation system connectivity, safety and mobility, and project readiness and viability.

Using the criteria and scoring method in **Table 3.4** as a base, intersection improvement recommendations were developed. **Map 3-6** displays the priority intersections for signal and curb ramp improvements for Greensboro.

INTERSECTIONS	
1. Land Use Connectivity *(Up to 8 points)*	
a. Project provides a connection to/from a neighborhood *(2 points)*	Each Land Use has connection to a project within: • 1/2 mile: *2 points* • 1 mile: *1 point* • > 1 mile: *0 point*
b. Project provides a connection to/from employment/retail center *(2 points)*	
c. Project provides a connection to/from a school *(2 points)*	
d. Project provides a connection to/from a park or recreation center *(2 points)*	

INTERSECTIONS	
2. Transportation System Connectivity *(Up to 14 points)*	
a. Does the project improve a connection to transit service? *(2 points)*	Bus stop is within: • 1/4 mile: *2 points* • 1/2 mile: *1 point*
b. Does the project connect to other transportation modes and/or transportation facilities? *(2 points)*	Identify 3 modes that the project connects to: Sidewalk; Bike; Transit. **Sidewalk has the highest priority in the list.** • If the project connects to 1 of 3 modes: *2 points* • Does not connect to any of these modes: *0 point*
c. Does the project connect to an existing facility of the same mode or fill a gap? *(3 points)*	• If the connecting mode in **2b** is Sidewalk: *3 points* • Does not connect to sidewalk: *0 point*
d. Is the project in an area underserved by bicycle & pedestrian infrastructure? *(3 points)*	• If there is no pedestrian signal at all legs of the intersection: *3 points* • If there is a pedestrian signal at some legs of the intersection AND at least 1 of the legs does not have any connection for the pedestrian to cross the street: *2 points* • If there is a pedestrian signal at some legs of the intersection AND the pedestrian still can use another way to cross the street: *1 point* • If there are pedestrian signals at all legs of the intersection: *0 point*
e. Does the project extend key parts of the regional greenway system (Bicentennial, Piedmont, A&Y, Downtown Greenway, Mountains to Sea Trail)? *(4 points)*	• If the project improves the connection to trails: *4 points* • Does not: *0 point*

TABLE 3.4
Pedestrian Signal and Curb Ramp Installation Criteria

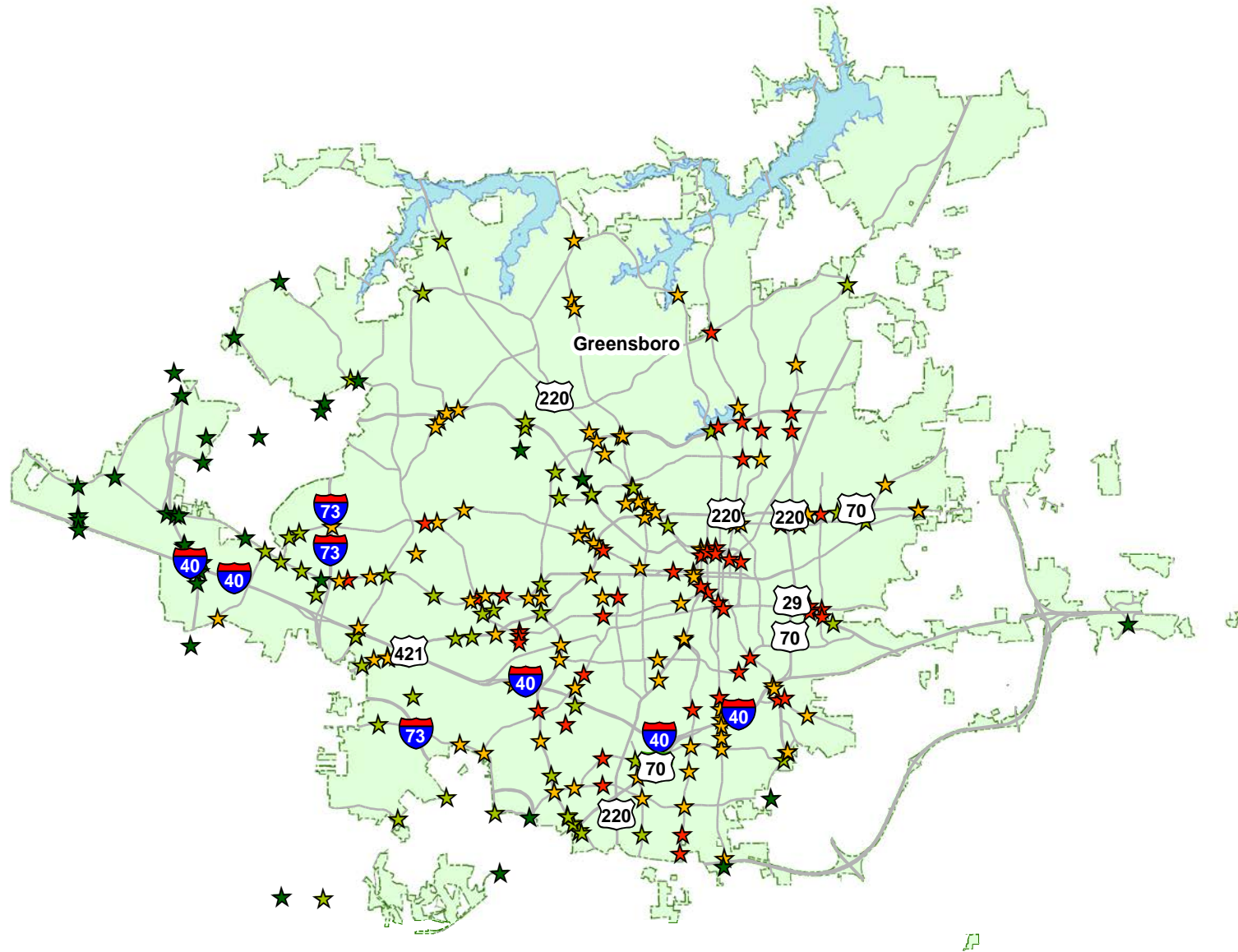| INTERSECTIONS	
3. Safety & Mobility *(Up to 8 points)*	
a. If applicable, does the project address an existing safety problem? *(3 points)*	• If there has been a recent pedestrian or bicycle crash within a 150 feet buffer from the project: *3 points* • Other safety issue (light, etc.): *2 points* • No safety problem identified: *0 point*
b. Does the project address a barrier to mobility? *(2 points)*	• If the project fills a gap (connect to existing sidewalk - see **2c**): *1 point* • If the intersection falls in a Census Tract with number of workers with no vehicle >54: *1 point*
c. Does the project improve mobility for disadvantaged populations, such as elderly, disabled, minority, and low income populations? *(2 points)*	If the intersection falls in the Census Block Group with the number of household poverty: • *>147: 2 points* • *≤147 and >96: 1 point* • *≤96: 0 point*

INTERSECTIONS	
4. Project readiness and viability *(Up to 14 points)*	
a. Is the project or project phase very likely to meet funds obligation requirements in the funding availability timeframe? *(Very likely: 4 points) (Somewhat likely: 2 points)*	If the percentage of completed design is at: • ≥90%: *4 points* • ≥75% and < 90%: *3 points* • ≥50% and <75%: *2 points* • ≥25% and <50%: *1 point* • <25%: *0 point*
b. Is the project/program part of an adopted plan? *(2 points)*	• Yes: *2 points* • No: *0 point*
c. Does the project have demonstrated local government support? *(2 points)*	• Yes: *2 points* • No: *0 point*
d. Does the project have demonstrated community/public support? *(3 points)*	• Yes: *2 points* • No: *0 point*
e. Does the project have a documented source for the required 20% match and any other necessary and additional local expenditures? *(2 points)*	• Yes: *2 points* • No: *0 point*
f. Is right of way in hand or is acquisition in process using local funds? *(2 points)*	If the percentage of acquired ROW is at: • ≥90%: *2 points* • ≥50% and <90%: *1 point* • <50%: *1 point*

TABLE 3.4
Pedestrian Signal and Curb Ramp Installation Criteria

Map 3-6

INTERSECTION
IMPROVEMENT
-
CITY OF
GREENSBORO

Legend

**Intersection Improvement
TotalScore**

★ 22 - 27 (Low Priority)

★ 28 - 32

★ 33 - 36

★ 37 - 42 (High Priority)

Major Street

Lakes

City of Greensboro

Greensboro